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ABSTRACT

This booklet answers questions of parents about the metric system, presenting a concise overview. Prefixes, terminology, and notation essential to the metric system are clearly detailed. The basic concepts of length, area, volume, temperature, and mass are presented with illustrations and tables. (JW)

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METRICS THE MEASURE OF YOUR FUTURE

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A PARENT'S GUIDE TO HOMEWORK

For use in the Winston-Salem/Forsyth County School System

Marvin Ward, Superintendent
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ESEA Title III - Grant No. 43-74-259
Division of Development, North Carolina Department of Public Instruction

Centimeters

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NOTE TO PARENTS:

The purpose of this booklet is to make it easier for you to help your child learn the metric system. You may or may not know it very well yourself. And if you grew up in this country, it may seem strange to you for a long time, as it does to those of us who work in the schools. Maybe you would rather not change - some of us may agree with you. But it is a fact that all other industrialized nations will use the metric system in the future, and increasingly so will we. Common sense tells us we must make our products acceptable to the rest of the world or lose their trade, with drastic economic results.

So the jobs of the future will require a knowledge of the metric system - many already do. The sooner we can get children started with metrics, the easier it will be for them. If they learn metric measurements during elementary school or junior high, they will never have to meet the far more difficult task of changing from one system to another.

But measurement is not just something that is learned in an arithmetic class. It includes a lot of understandings and activities that develop gradually over a long period of time. It begins when the newborn infant is measured and weighed and continues as he observes formulas prepared, food served, clothing fitted, and objects compared. By the time he is nine years old, the child usually has learned what it means to measure length, weight and capacity; by the time he is twelve or thirteen, he generally understands area and volume and has acquired the basic measurement skills for his daily life. Beyond this he may need to learn specialized measures for his vocation, hobbies and other interests.

In our schools, we will try to make nearly all our measurement activities metric. A few will not be - we want children to understand those who have not yet gone metric, too.

And at home, we ask that you help by using some of the hints we offer here. Make some metric measuring tools; look for metrics on any new ones you buy. Use them often around your home, so that your child can see that you consider them important. Talk with him about what he measures, and encourage him to think metric first. Then for him, using metrics will just be a natural, easy way to get a necessary job done.

Answers to 5 most-asked questions of parents

1. Why should we change to metric?

Because over 95% of the people in the world are using it. We want to be able to understand what they say and write, and we want them to understand us, especially when it concerns selling and buying manufactured goods, machines, tools, and repair parts.

2. Won't it be hard to learn?

No. It is a decimal system, like our money, and much easier to learn and use than our customary way. Elementary students will have no problem with it. Secondary students and adults will soon "think metric," too. There are only a few new words to learn, and you don't have to know them all at once. Just notice metric measurements all around you now - you will be suprised at how often they are used already and how little it bothers you.

3. How can I get started?

Make a meter stick. Start with a strip of cardboard or wood 40 inches long (bet you had to measure that - we don't really know how long a yard or an inch is unless we measure!) Use the centimeter ruler on the front of this paper to mark it off in centimeters; one hundred centimeters is one meter. Cut off the extra length - less than an inch. Now look at your pencil or pen. Estimate how many centimeters long it is. Measure it. Estimate the width of your desk or table. Measure it. Estimate...measure. In no time you will be as accurate with meters and centimeters as you are with yards and inches.

4. Can I also make a liter measure?

That's easy. A wide-mouthed quart mayonnaise jar filled to the top is a liter. A quart milk carton with the spout open holds a liter. A ten-gallon can holds about 38 liters. Besides, how long is it since you measured anything by the gallon (the gas pump does the measuring!)

5. But what about those little grams?

No problem. You seldom weigh a single paper clip or thumb tack. Mostly you weigh yourself or look at the weight of things you are buying. A pound is about 450 grams. One kilogram is 2.2 pounds. Ten kilograms - 22 pounds. When grocery stores start selling by the kilogram, they will start using metric scales. Until then, learn from the packaged food you buy. And if you buy any measuring equipment, be sure it has metric markings!

6. If it is so easy, why didn't we change to metrics long ago?

Sorry, I have found no logical answer for that one. People tend to avoid the unfamiliar, and forget that to live is to change. One thing is sure. We can learn, and we are changing.

So What IS a Metre, Really?

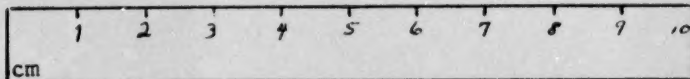
The metre is the base unit of the metric system. It was chosen originally as 1/10,000,000 of the distance from the equator to the North Pole -- a "natural" part of the earth itself. Scientists then believed the earth to be a sphere. Now that we know that the world is not in perfect shape (!), the metre is defined in terms of krypton-86 wavelengths.

The metre is a little longer than our customary yard, a bit over 39 inches. It is divided into 10 equal parts called decimetres (deci means one tenth; ten decimetres make one metre). Your hand is probably about a decimeter wide.

Each decimetre is divided into 10 equal parts called centimetres (centi means one hundredth; one hundred centimetres make one metre). Your little fingernail is probably about a centimetre wide.

Each centimetre is divided into 10 equal parts called millimetres (milli means one-thousandth; one thousand millimetres make one metre). A dime is about one millimetre thick.

The metre will be used to measure length, area (in square metres), and volume (in cubic metres). A special name for the cubic decimetre is litre, which is slightly more than the liquid quart. And one litre of pure, cold water has a mass of one kilogram.



10 centimetres = 1 decimetre
100 centimetres = 1 metre



10 millimetres = 1 centimetre
1 000 millimetres = 1 metre

Spell that for me, please...

Chances are, if you say that to someone writing a paragraph about metric measurements, that he will become uneasy or defensive. The problem comes from two hundred years of increasing metric usage without any truly international agreement. As each nation used the system, it spelled the words in a way that seemed compatible with its own language. Those with French connections kept metre and litre. Others settled on such variations as meter (most English-speaking nations), metr, metro, etc.

When the metric system was modernized in 1960 by the General Conference on Weights and Measures, the resulting version was called the Systeme International, usually referred to as SI. It set up these preferred spellings and symbols for the most commonly used words and prefixes:

metre	m	kilo	k
litre	l	hecto	h
gram	g	deka	da
Celsius	C	deci	d
second	s	centi	c
tonne	t	milli	m

We will use these in teaching the metric system, hoping that eventually everyone will accept a common form, but we know that other spellings will still be in use for a long time. They aren't wrong, and they won't trouble us when others use them. Maybe in years to come they will even be the "preferred" way. Until then, in our classes we will try to use SI forms.

There are some preferred ways of writing metric measurements, too. For example, the prefix and the unit name are not separated:

write milligram not milli gram

Words are made plural by adding an s, but symbols are not:

write 15 kilograms = 15 kg not 15 kgs

Symbols are separated from the number they identify by a space:

write 142 kg not 142kg

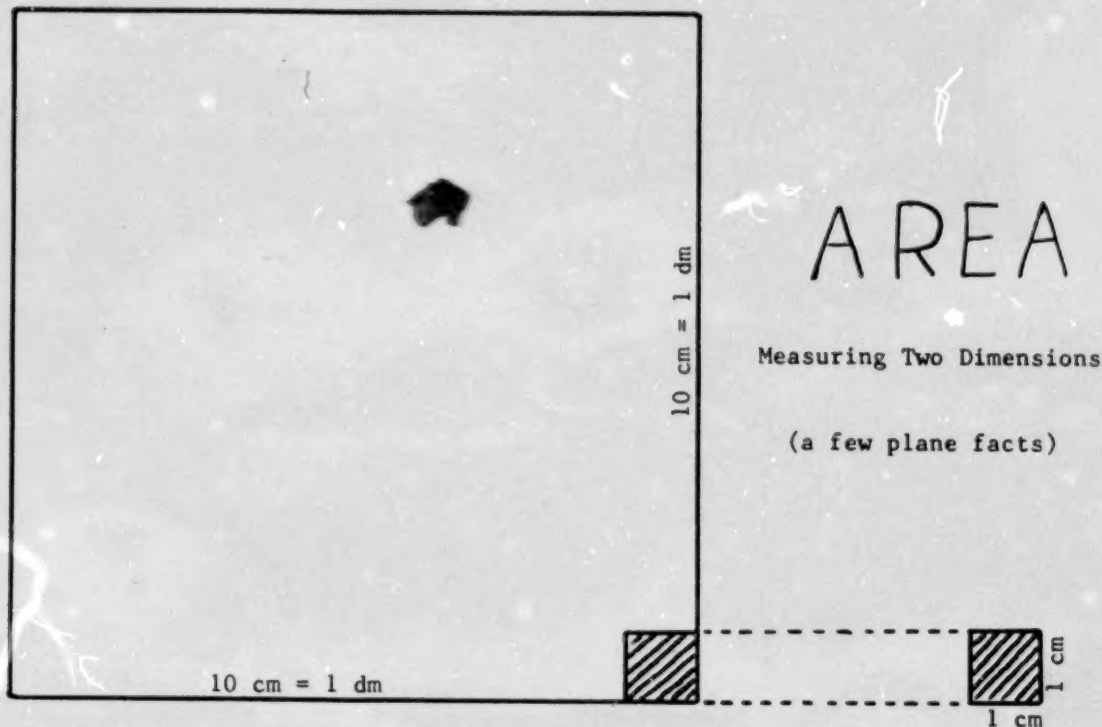
Large numbers are separated into groups of three digits but without commas (many people in other countries use a comma for the decimal point and periods only at the end of a sentence).

write 15 942.6 km not 15,942.6 km

Use a decimal to express partial units rather than common fractions; use a zero before the decimal point when the measure is less than one unit:

write 0.25 m not $\frac{1}{4}$ m

In the long run, all the people of the world will have a hand in deciding whether these SI standards are the best ones for future use - if not, they will surely be changed!



$$\begin{aligned}
 10 \text{ cm} \times 10 \text{ cm} &= 100 \text{ cm}^2 \\
 1 \text{ dm} \times 1 \text{ dm} &= 1 \text{ dm}^2 \\
 \text{therefore } 100 \text{ cm}^2 &= 1 \text{ dm}^2 = 1 \text{ square decimetre}
 \end{aligned}$$

$$\begin{aligned}
 1 \text{ cm} \times 1 \text{ cm} &= 1 \text{ cm}^2 \\
 \text{or } 1 \text{ square centimetre}
 \end{aligned}$$

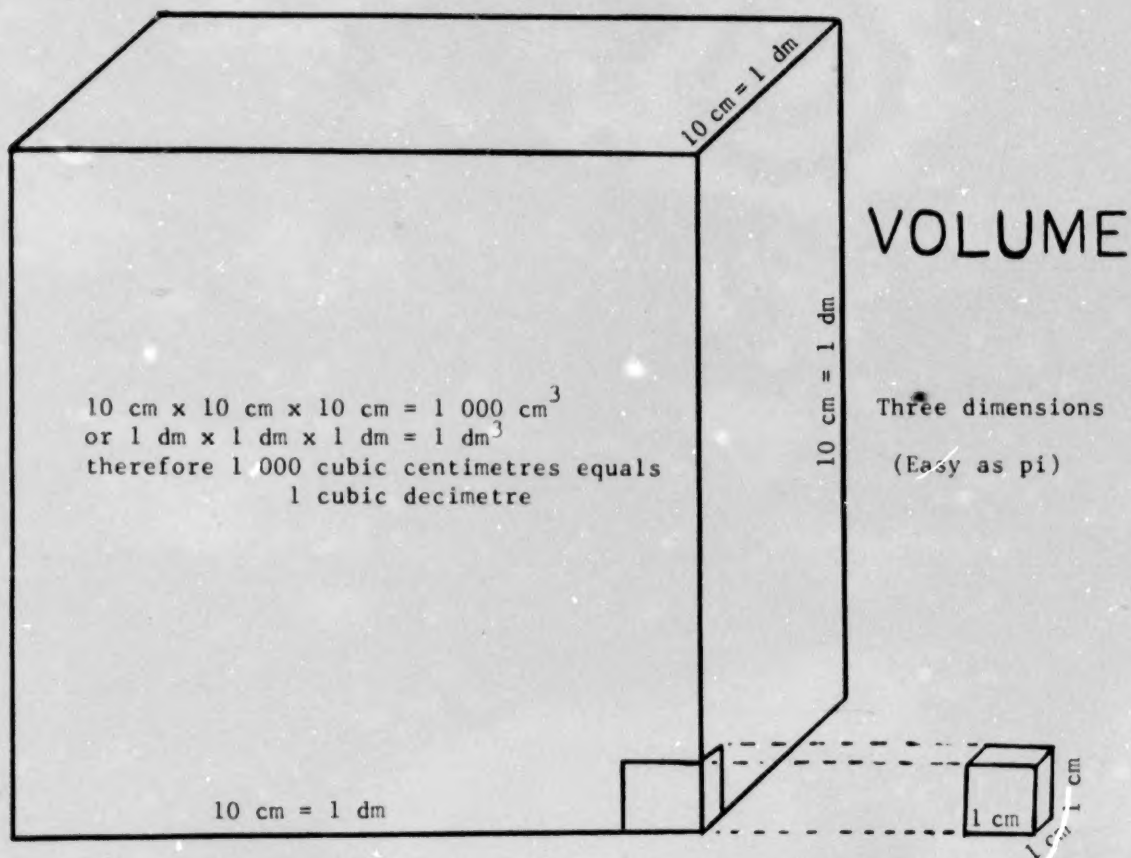
$$\begin{aligned}
 10 \text{ dm} &= 1 \text{ m} \\
 10 \text{ dm} \times 10 \text{ dm} &= 100 \text{ dm}^2 = 1 \text{ m}^2 = 1 \text{ square metre}
 \end{aligned}$$

Notice that each square unit is 100 times as great as the next smaller square unit.

$$\begin{aligned}
 \text{So } 1 \text{ dam}^2 &= 100 \text{ m}^2 \\
 1 \text{ hm}^2 &= 100 \text{ dam}^2 \\
 1 \text{ km}^2 &= 100 \text{ hm}^2
 \end{aligned}$$

The square dekametre is usually called an are (1 a), and is about the size of half a tennis court. The square hectometre is usually called a hectare (1 ha) and is about 2.5 acres. These terms are used for land measure. Square kilometres are used to measure a county, state, or other large area.

Square metres are just right for buying carpet (a little more than a square yard). And square centimetres work best for measuring small areas like the size of a postage stamp or a snapshot.



$$1 \text{ dm}^3 = 1\,000 \text{ cm}^3$$

$$1 \text{ m} = 1\,000 \text{ dm}$$

$$1 \text{ cm} \times 1 \text{ cm} \times 1 \text{ cm} = 1 \text{ cm}^3$$

$$\text{or } 1 \text{ cubic centimetre}$$

Note that each cubic unit is 1000 times the next smaller cubic unit. Remember, too, that $1 \text{ dm}^3 = 1 \text{ litre}$ and $1 \text{ cm}^3 = 1 \text{ millilitre}$. An extremely valuable relationship of the metric system is illustrated by these facts:

1 cubic centimetre of cold water = 1 millilitre and weighs 1 gram

1 cubic decimetre of cold water = 1 litre and weighs 1 kilogram

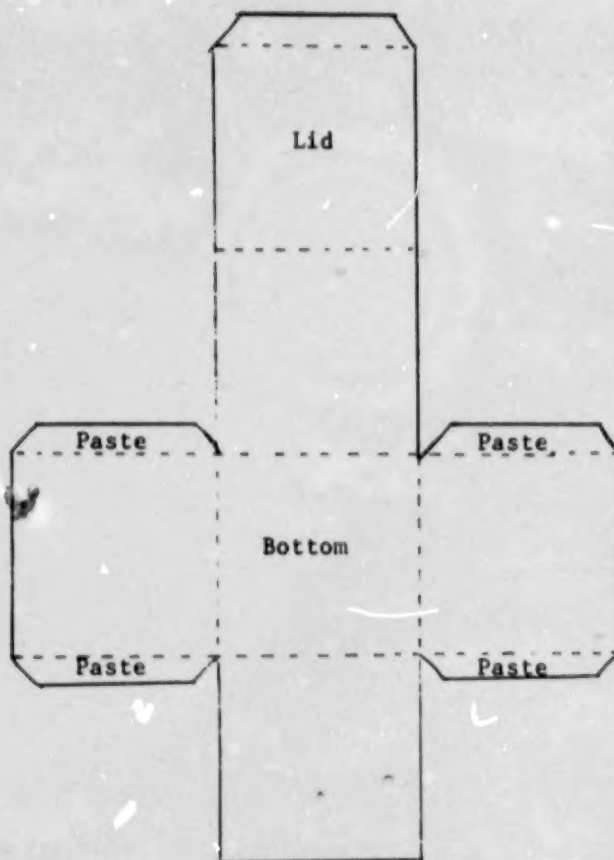
1 cubic metre of cold water = 1 kilolitre and weighs 1 000 kg or 1 metric ton

Notice that you could easily determine the volume or capacity of any container by weighing the cold water it will hold, regardless of its shape. That is a lot easier than $V = \pi r^2 h$, the formula for the volume of a cylinder.

THE LITRE

a HOLDING pattern

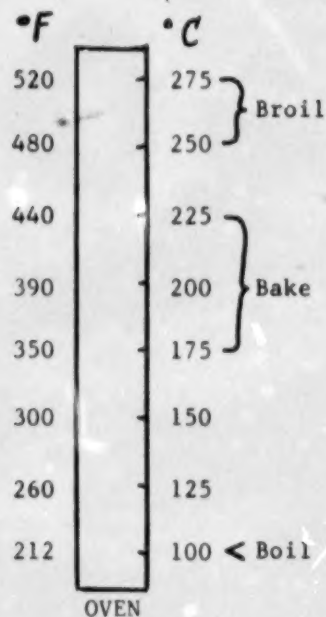
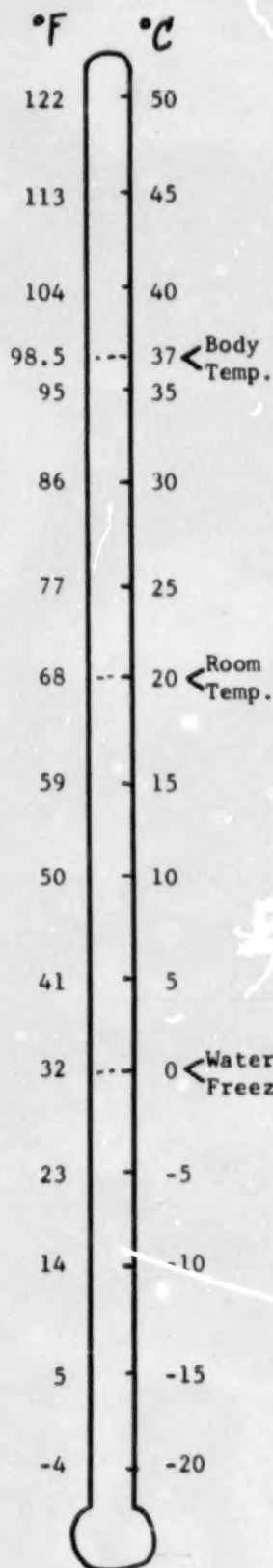
If you make a box using a pattern shaped like this with each side a square decimetre, the box will hold one litre.



Things that pour, or do not hold a shape well, are usually measured in litres. Since a litre is just slightly larger than a quart, you will buy the same number of litres of milk as you have been buying quarts. But your gasoline tank will hold nearly four times as many litres as gallons; watch the price - it should be just a little more than one-fourth that of a gallon.

Smaller quantities are measured in millilitres - it takes five to fill a teaspoon, fifteen for a tablespoon, 240 for a 'standard' measuring cup, and 1 000 millilitres to fill a litre measure.

A kilolitre is 1 000 litres and is sometimes used for measuring the capacity of large containers like storage tanks, dye vats, or swimming pools. Remember, a kilolitre of cold water will fill a cubic metre and weigh a metric ton. Now that's a waterbed!



Celsius is the name of the man who invented the temperature scale we used to call centigrade - it has been renamed in his honor.

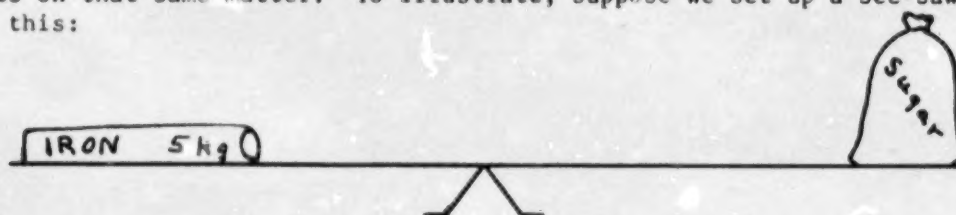
- Water boils at 100 degrees Celsius.
- Water freezes at 0 degrees Celsius.
- We are asked to keep our homes at 20 degrees Celsius in winter to conserve fuel.

TEMPERATURE

MASS - a MATTER of WEIGHT

"Mass? Why not just say weight?" Twenty years ago the answer to that question was left strictly to scientists. But when the first astronaut put his foot on the surface of the moon, "weightlessness" had become a practical problem and a household word. Obviously, his body was just as big as it had been back on earth. But a measurement had changed.

In order to understand and talk about such happenings, we need to become more precise in our language. Technically, MASS is used to indicate the quantity of matter that is measured, and WEIGHT refers to the force that gravity exerts on that same matter. To illustrate, suppose we set up a see-saw like this:



If the bag of sugar exactly balances the iron bar, we say that the sugar has a MASS of 5 kilograms.

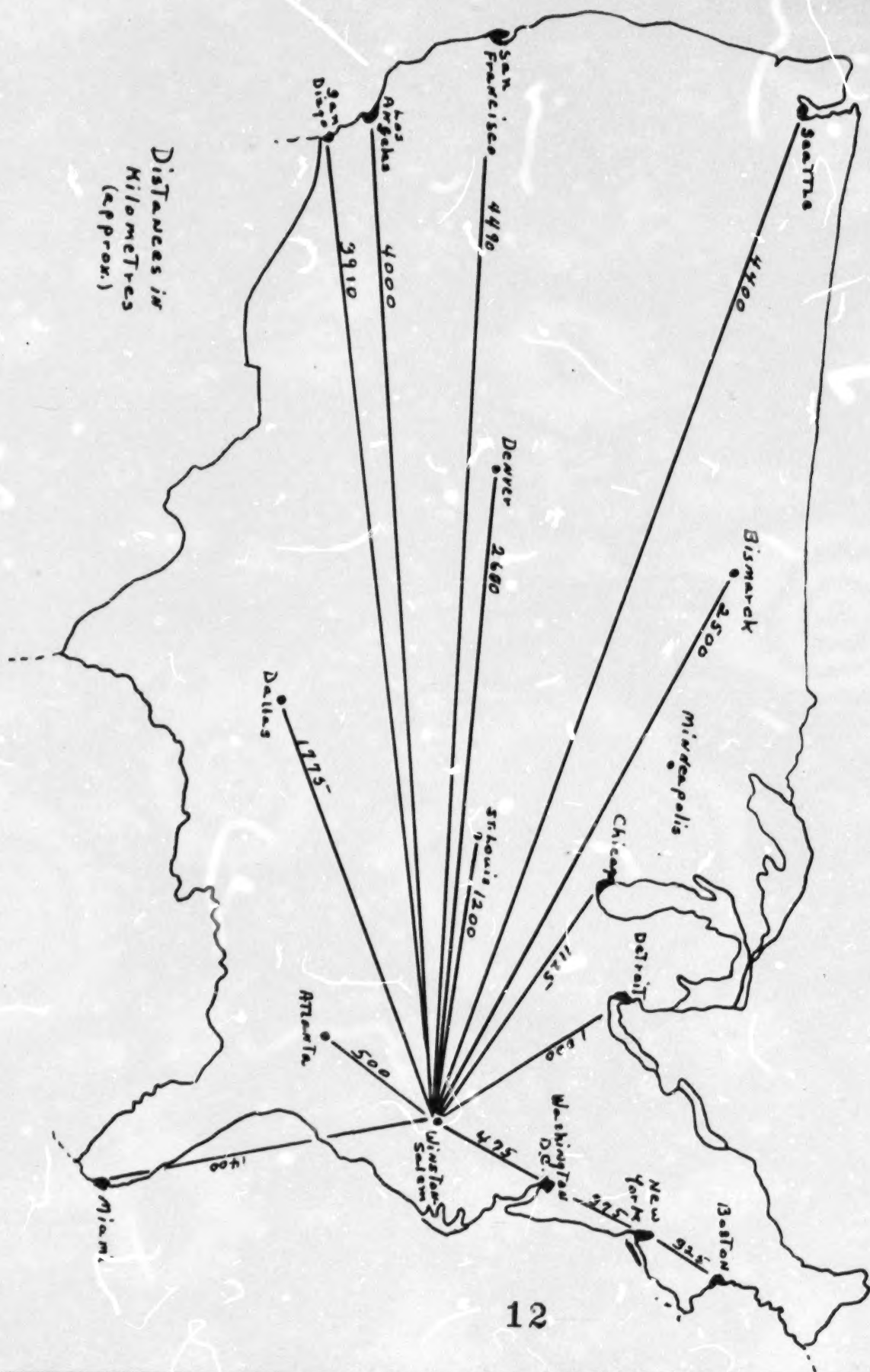


Next we hang the bag on a spring scale. When the indicator moves down to 5, we say the sugar WEIGHS 5 kilograms.

Now suppose that we send bar, see-saw, sugar and scale all on the next space flight. Set up on the moon, the iron bar and the bag of sugar still balance perfectly on the see-saw. The MASS is still 5 kilograms. But hung on the spring scale, the bag WEIGHS less than one kilogram, because moon gravity is so much less than earth gravity.

Why do we raise the question? Well, mainly to show that there is a way to say exactly what you mean. And there are times, as in a laboratory or on the moon, when precision is extremely important. Back on earth, and in everyday life, it doesn't usually matter and everyone understands you anyway. As for us, we just hope you think kilograms whenever you use either word!

Distances in
Kilometres
(approx.)



AN OUTLINE OF HISTORY - METRIC, THAT IS

- 1670 Gabriel Mouton, Vicar of St. Pauls Church in Lyons, proposed a decimal system based on an arc of a great circle of the earth.
- 1786 Decimal system of coinage, developed by Thomas Jefferson and Robert Morris, adopted by Congress - base unit the dollar.
- 1790 Decimal system of weights and measures proposed by Jefferson but rejected.
- 1795 Metric system developed by the French Academy of Science made mandatory in France (and imposed on Holland and Belgium in defeat).
- 1798 First International Conference on Weights and Measures called by Talleyrand.
- 1821 John Quincy Adams recommended that the United States not change until both England and Spain agreed. They did not.
- 1850 Spain, Greece, Norway and part of Italy adopted the metric system.
- 1866 Act of Congress made metric system legal but not mandatory in the U.S.
- 1868 Germany and Portugal adopted the metric system.
- 1875 U.S. signed "Treaty of the Meter" with 17 countries.
- 1893 All United States measurements redefined in terms of the metre.
- 1960 SI Metric System adopted by Eleventh General Conference - this modernized version amounts to an international language of weights and measures.
- 1965 England goes metric and changes to a decimal money system.
- 1968 Congress orders a study of the probable effects of making the metric system mandatory and asks for recommendations.
- 1970 Canada adopts a conversion plan.
- 1971 Study Commission reports that the United States is gradually going metric on a voluntary basis; that the change will be easiest and least expensive if carried out over a carefully planned ten-year period; and that educational efforts must be increased to meet work force needs.
- 1974 Congress passes Public Law 93-380 "...to encourage educational agencies and institutions to prepare students to use the metric system..."
- 1975 Congress passes Public Law 94-168 to set up a Metric Conversion Board to plan U.S. conversion. We have joined the metric world!

RELATIONSHIPS WITHIN THE METRIC SYSTEM

1 kilometre	= 10 hectometres	= 100 dekametres	= 1 000 metres
0.1 kilometre	= 1 hectometre	= 10 dekametres	= 100 metres
0.01 kilometre	= 0.1 hectometre	= 1 dekametre	= 10 metres
0.001 kilometre	= 0.01 hectometre	= 0.1 dekametre	= 1 metre
1 metre	= 10 decimetres	= 100 centimetres	= 1 000 millimetres
0.1 metre	= 1 decimetre	= 10 centimetres	= 100 millimetres
0.01 metre	= 0.1 decimetre	= 1 centimetre	= 10 millimetres
0.001 metre	= 0.01 decimetre	= 0.1 centimetre	= 1 millimetres

Note: The Metric System is consistent. In the above table, litre or gram may be substituted for metre and the table is still true.

AREA IN THE METRIC SYSTEM

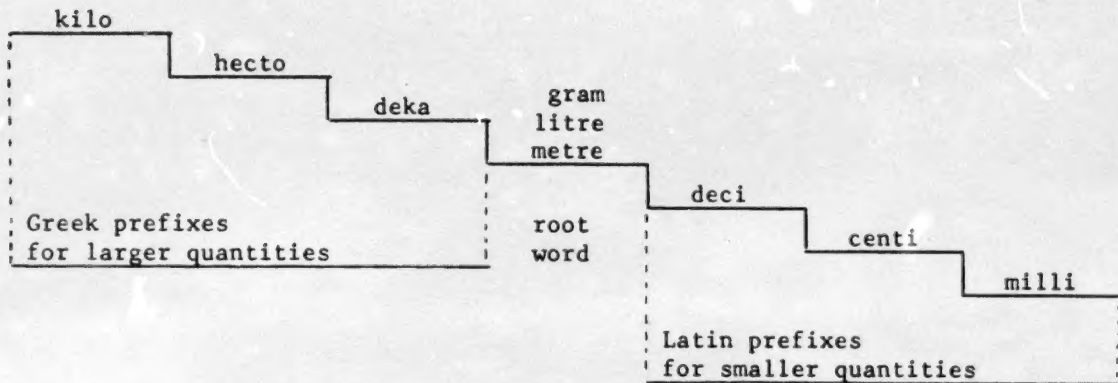
Measure	Symbol	Relationship
Square centimetre	cm ²	1 cm ² = 100 mm ²
Square decimetre	dm ²	1 dm ² = 100 cm ²
Square metre	m ²	1 m ² = 100 dm ²
Are (Sq. dekametre)	a	1 a = 100 m ²
Hectare (Sq. hectometre)	ha	1 ha = 100 a = 2.5 acres
Square kilometre	km ²	1 km ² = 100 ha

metre = meter
litre = liter

VOLUME IN THE METRIC SYSTEM

Measure	Symbol	Relationship
Cubic centimetre	cm ³	1 cm ³ = 1 000 mm ³
Cubic decimetre	dm ³	1 dm ³ = 1 000 cm ³
Cubic metre	m ³	1 m ³ = 1 000 dm ³
		1 cm ³ = 1 ml
		1 dm ³ = 1 l
		1 m ³ = 1 kl

CONVERSIONS
(one step at a time)



Each unit is 10 times as large as the next one to its right, and one-tenth as large as the next one to its left. Example: 1 hectogram = 10 dekagrams
1 hectogram = 0.1 kilogram

Since the metric system is a decimal system, it is easy to change from one unit to another. Simply count the number of steps from the unit to the other, and move the decimal that many steps in the same direction. (If you need to use an empty space, fill it with a zero!)

Example 1: 1.4 hectograms = ? grams

From hectogram to gram is two steps to the right; therefore the decimal moves two places to the right.

Answer 1: 1.40 hectograms = 140 grams (Note the zero.)

Example 2: 275 grams = ? kilograms

From grams to kilograms is three steps left; therefore move the decimal three places left.

Answer 2: 275 grams = 0.275 kilograms (Note the zero.)

Note: The metric system is consistent; metre or litre may be substituted for grams and the examples are still true.

HOW TO CHANGE FROM ONE UNIT TO ANOTHER WITHIN THE METRIC SYSTEM

When you are given	You multiply by this number to change to						
	millimetres	centimetres	decimetres	metres	dekametres	hectometres	kilometres
mm	1	0.1	0.01	0.001	0.0001	0.00001	0.000001
cm	10	1	0.1	0.01	0.001	0.0001	0.00001
dm	100	10	1	0.1	0.01	0.001	0.0001
m	1 000	100	10	1	0.1	0.01	0.001
dam	10 000	1 000	100	10	1	0.1	0.01
hm	100 000	10 000	1 000	100	10	1	0.1
km	1 000 000	100 000	10 000	1 000	100	10	1

SOME VERY LARGE MEASURES:

megametre = 1 000 kilometres
gigametre = 1 000 megametres
terametre = 1 000 gigametres

SOME VERY SMALL MEASURES:

micrometre = 0.001 millimetre
nanometre = 0.001 micrometre
picometre = 0.001 nanometre
femtometre = 0.001 picometre
attometre = 0.001 femtometre

NOTE:

The Metric System is consistent. In the above, litre or gram may be substituted for metre and the tables are still true.

METRIC REFERENCE TABLE

Root Word	Added Prefix	Prefix Means	Results	Written as a Measure	Written as a Unit	For Daily Use	Approximate Equivalent
(1) METRE							
	milli	1/1000	1 millimetre	0.001 m	1 mm	yes	0.039 inches
	centi	1/100	1 centimetre	0.01 m	1 cm	yes	0.39 inches
	deci	1/10	1 decimetre	0.1 m	1 dm	avoid	
			1 metre	1 m	1 m	yes	39.37 inches
	deka	10	1 dekametre	10 m	1 dam	avoid	
	hecto	100	1 hectometre	100 m	1 hm	avoid	
	kilo	1000	1 kilometre	1 000 m	1 km	yes	0.62 miles
(2) LITRE							
	milli	1/1000	1 millilitre	0.001 l	1 ml	yes = 1 cm ³	0.03 fluid ounce
	centi	1/100	1 centilitre	0.01 l	1 cl	avoid	
	deci	1/10	1 decilitre	0.1 l	1 dl		
			1 litre	1 l	1 l	yes = 1 dm ³	1.06 quarts
	deka	10	1 dekalitre	10 l	1 dal	avoid	
	hecto	100	1 hectolitre	100 l	1 hl	avoid	
	kilo	1000	1 kilolitre	1 000 l	1 kl	yes = 1 m ³	264 gallons
(3) GRAM							
	milli	1/1000	1 milligram	0.001 g	1 mg	yes - science and medicine avoid	
	centi	1/100	1 centigram	0.01 g	1 cg	avoid	
	deci	1/10	1 decigram	0.1 g	1 dg	avoid	
			1 gram	1 g	1 g	yes	0.35 ounce
	deka	10	1 dekagram	10 g	1 dag	avoid	
	hecto	100	1 hectogram	100 g	1 hg	avoid	
	kilo	1000	1 kilogram*	1 000 g	1 kg	yes	2.2 pounds

* 1 000 kilograms = 1 metric tonne (t) = 1.1 short tons

All You Will Need to Know About Metric

(For Your Everyday Life)

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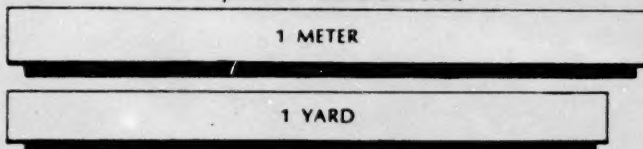
Metric is based on Decimal system

The metric system is simple to learn. For use in your everyday life you will need to know only ten units. You will also need to get used to a few new temperatures. Of course, there are other units which most persons will not need to learn. There are even some metric units with which you are already familiar: those for time and electricity are the same as you use now.

BASIC UNITS

METER: a little longer than a yard (about 1.1 yards)
LITER: a little larger than a quart (about 1.06 quarts)
GRAM: about the weight of a paper clip

(comparative sizes are shown)



25 DEGREES FAHRENHEIT

COMMON PREFIXES

(to be used with basic units)

Milli: one-thousandth (0.001)
Centi: one-hundredth (0.01)
Kilo: one-thousand times (1000)

For example:

1000 millimeters = 1 meter
 100 centimeters = 1 meter
 1000 meters = 1 kilometer

1 LITER

1 QUART



OTHER COMMONLY USED UNITS

Millimeter: 0.001 meter diameter of paper clip wire
Centimeter: 0.01 meter width of a paper clip (about 0.4 inch)
Kilometer: 1000 meters somewhat further than 1/2 mile (about 0.6 mile)
Kilogram: 1000 grams a little more than 2 pounds (about 2.2 pounds)
Milliliter: 0.001 liter five of them make a teaspoon

OTHER USEFUL UNITS

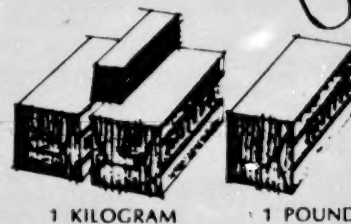
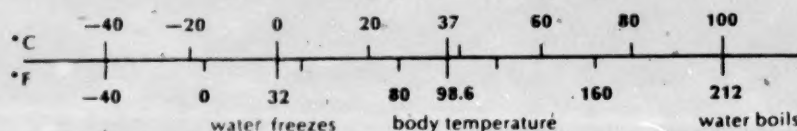
Hectare: about 2 1/2 acres
Tonne: about one ton



25 DEGREES CELSIUS

TEMPERATURE

degrees Celsius are used



1 KILOGRAM

1 POUND

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